talks included (attached)

# 28th PLANT DEVELOPMENT WORKSHOP 1993

## Saturday, March 20

## Trent University Peterborough, ON

## PROGRAM

Registration.....09:00-09:30

Welcome by Dr. Colin Taylor, Assoc. Dean, Graduate Studies.....09:30-09:40

Opening lecture by Dr. Larry Peterson, University of Guelph:
"Cellular and sub-cellular alterations in symbionts during vesicular-arbuscular mycorrhiza formation".....09:40-10:30

Coffee Break.....10:30-10:45

Contributed papers.....10:45-12:15

Lunch and Posters.....12:15-13:45

Contributed papers.....13:45-15:00

Coffee Break.....15:00-15:15

Closing lecture by Dr. Stewart Brown, Trent University:
"Coumarins in the interaction between plant and environment"..15:15-16:15

Reception.....16:15-18:00

## CONTRIBUTED PAPERS

Oral Presentations

10:45 Persaud, D., Cragg, G., Elliott, B., Glowniak, K., Furmanowa, M. and Zobel, A.M.
"Taxol and its derivatives as anticancer agents"

11:00 Smith, J. and Zobel, A.M.
"A questionable usage of xanthotoxin as an anticancer drug"

11:15 Keightley, A. and Zobel, A.M.
"Coumarin and some of its derivatives as anticancer agents"

11:30 Gervais, C., Simmonds, D.H. and Newcomb, W.
"Microfilaments in microspore and embryo development of *Brassica napus* cv. Topas"

11:45 Mckenzie, B.B. and Peterson, C.A.
"Browning in tree roots: causes and consequences"

12:00 Peterson, C.A., Murrmann, M. and Steudle, E.
"Location of the major barriers to water and ion movement in young roots of *Zea mays* L."

13:45 Evans, R.C. and Dickinson, T.A.
"Floral development of 10- and 20-stamen varieties of *Crataegus douglasii*" Lindl. (Rosaceae: Maloideae)"

14:00 Stewart, H.
"Reproductive biology of *Agalinis neoscotica*"

14:15 Dunlop, S.
"Plant communication"

14:30 Chen, Y. and Zobel, A.M.
"Bad and good UV influence on *Ruta graveolens* leaves"

14:45 Crellin, J. and Zobel, A.M.
"Furanocoumarins as phytoalexins in celery and rue"

Posters

P-1 Barabé, D.
"The phyllotaxis of the inflorescence of *Symplocarpus foetidus*"

P-2 Leroux, G., Barabé, D. and Vieth, J.
"The morphogenesis of the protocorm of *Cypripedium* acaule Aiton (Orchidaceae)"

P-3 Beecroft, P. and Lott, J.
"Identification of the sites of solute leakage from imbibing seeds and grains"

P-4 Crang, R., Kuras, M. and Zobel, A.M.
"Lead uptake into soybean root cells as influenced by pH"

P-5 Snelgrove, J., Bazdikian, J., March, R.E. and Zobel, A.M.
"Identification of compounds produced in response to UV"

P-6 Wierzbicka, M. and Zobel, A.M.
"Uptake and translocation of $PbSO_4$ by root and shoot promeristems"

P-7 Gadzala, M. and Zobel, A.M.
"Epicatechins from *Sambucus racemosa* inhibit mitosis in the promeristem"

P-8 Barrett, S., Ruchirawat, A. and Zobel, A.M.
"Influence of coumarin and xanthotoxin on oxygen consumption"

P-9 Podbielkowska, M., Piwocka, M., Waszkowska, E., Waleza, M. and Zobel, A.M.
"Effect of coumarin and its derivatives on mitosis and ultrastructure of meristematic cells of Allium cepa"

P-10 Lazaruk, L., Plaxton, W. and Zobel, A.M.
"Localization of PKc and PKp in germinating embryos of Brassica"

P-11 Kupidlowska, E., Kowalec, M., Sulkowski, G. and Zobel, A.M.
"Effect of coumarins on root elongation and ultrastructure"

# CELLULAR AND SUB-CELLULAR ALTERATIONS IN SYMBIONTS DURING VESICULAR-ARBUSCULAR MYCORRHIZA FORMATION.

Larry Peterson, Department of Botany, University of Guelph. Guelph, Ontario N1G 2W1

Vesicular-arbuscular mycorrhizas are the most prevalent mutualistic symbioses in the plant kingdom. The fungi involved are obligate symbionts and therefore interact closely with roots during the establishment of the association. Appressoria are induced as hyphae contact the root surface and, concomitantly, changes occur in epidermal cells. Penetration hyphae develop from appressoria and initiate the internal colonization phase. Arbuscules, highly branched hyphae within cortical cells, and vesicles complete the internal development. Alterations in the cytoplasm and cell wall of the fungus accompany the development of these structures. Recent work with various alfalfa nodulation genotypes has provided evidence that the plant genome plays an important role in the colonization process.

TAXOL AND ITS DERIVATIVES AS ANTICANCER AGENTS. D. Persaud[1], G. Cragg[2], B. Elliott[3], K. Glowniak[4], M. Furmanowa[5] and A.M. Zobel[1].

[1]Chemistry, Trent University, Peterborough, ON K9J 7B8, [2]National Cancer Institute, Frederick, MD 21702, U.S.A., [3]Cancer Institute, Queen's University, Kingston, ON K7L 3N6, [4]Pharmacology, Medical Academy, Lublin 20-007, Poland, and [5]Pharmacy, Medical Academy, Warsaw 02-097, Poland.

Taxol -- a clinically used anticancer drug -- and six of its derivatives, were investigated as antimitotic agents using plant meristematic cells and murine mammalian carcinoma cultured cells. Taxol, even in a million times lower concentration than used clinically, inhibited mitosis after 24 h. Short-term expe riments (1 h) permitted observations on particular phases of mitosis, revealing the disturbing fact that taxol causes chromo somal aberrations. We suggest that a mixture of compounds from *Taxus* which actively inhibit cancer cells would be preferable in clinical application to a single compound, owing to the possibi lity of synergistical action with still-unidentified components.

A QUESTIONABLE USAGE OF XANTHOTOXIN AS AN ANTICANCER DRUG.
J. Smith and A.M. Zobel, Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Xanthotoxin has been used clinically as an anticancer drug for treatment of skin neoplasms, but our data show that this compound in darkness, and even more when irradiated, causes chro mosomal aberrations and structural changes in the cytoplasm leading to plasmolysis after plasma membrane permeability has been altered. Observations in the electron microscope after a very short time of xanthotoxin reaction permitted us to investi gate the primary sites of its reaction.

COUMARIN AND SOME OF ITS DERIVATIVES AS ANTICANCER AGENTS.
A. Keightley and A.M. Zobel, Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Coumarin did not cause aberrations while stopping mitosis in both plant and cancer cells, and thus shows promise as a potential anticancer drug. Coumarin has been only recently used in clinical treatment of prostate cancer (Marshall *et al.*, 1991). Substitution of hydroxyl groups in the coumarin aromatic ring lowers the ability of the compound to inhibit cell divisions, but still does not result in aberrations. Substitution of methyl groups lowers the inhibition of mitosis and leads to chromatid bridges, while methoxyl substitution enhances mitosis and causes the structure of the chromosome to be more dispersed than that of the control. This points to the fact that a single substitution changes the mechanism of coumarin action on chromosomes. GOOD AND

## MICROFILAMENTS IN MICROSPORE AND EMBRYO DEVELOPMENT OF *BRASSICA NAPUS* CV. TOPAS

Carmen Gervais[1], Daina H. Simmonds[2] and William Newcomb[1],[1]Department of Biology, Queen's University, Kingston, Ont.,[2]Plant Research Centre, Agriculture Canada, Ottawa, Ont.

The first mitosis in *Brassica napus* cv. Topas pollen development results in an asymmetrical division. A large vegetative and a small generative cell are formed. *B. napus* microspores isolated near the first mitosis and cultured at high temperature develop haploid embryos. The switch in the developmental pathway is characterized by a symmetrical division of the cytoplasm to form two equal sized daughter cells. The plane of division in most higher plant cells is determined by a preprophase band (PPB) of microtubules (MT). A PPB of MTs marks the division plane of induced microspores but is not present in normal pollen mitosis. Actin microfilaments (MF) have been visualized in the PPB of some higher plants. MFs have also been implicated in nuclear anchoring and maintaining the position of the spindle apparatus and therefore play a role in cell morphogenesis. Changes in MF organization in developing microspores and microspores after embryogenic induction are being analyzed using three MF labelling techniques.

## BROWNING IN TREE ROOTS: CAUSES AND CONSEQUENCES.

Mckenzie, B. Betty and Carol A. Peterson, Department of Biology, University of Waterloo, Waterloo, On, N2L 3G1

Growing tree roots are characteristically brown with white tips. This browning has been variously attributed to the deposition of suberin or lignin in the epidermis, cortex, endodermis, or some combination of these. However, in our pouch-grown seedlings of Pinus banksiana Lamb. and Eucalyptus pilularis Sm., root browning is not due to either suberization or lignification, but is correlated with the deposition of tannin in the walls of the epidermis and cortex. Vitality tests indicate that the cells of the epidermis and cortex are alive in the white zone but are dead in brown zones. The walls of the dead cells are permeable to berberine, and berberine thiocyanate crystals form in their lumina after potassium thiocyanate is added. The capacity of the brown zones to take up water and ions thus depends on the condition of the endodermis. Well-developed suberin lamellae in the endodermis of the brown zones suggest that their uptake capacity will be low.

## LOCATION OF THE MAJOR BARRIERS TO WATER AND ION MOVEMENT IN YOUNG ROOTS OF ZEA MAYS L.

Carol A. Peterson[1], Martina Murrmann[2] and Ernst Steudle[2], [1]Department of Biology, University of Waterloo, ON; [2]Lehrstuhl für Pflanzenökologie, Universität Bayreuth, Germany

It is generally assumed that the root endodermis provides a major barrier to the passage of water and ions as they move from the soil solution into the vascular tissues. We tested this idea using a root pressure probe (a unique instrument available only in Germany) by wounding roots in various patterns and measuring changes in their hydraulic conductivities and root pressures. The results indicated that a state 1 endodermis poses a major barrier to the movement of ions but not water. This is because membranes are relatively impermeable to ions but relatively permeable to water.

**FLORAL DEVELOPMENT OF 10- AND 20-STAMEN VARIETIES OF *CRATAEGUS DOUGLASII* LINDL. (ROSACEAE: MALOIDEAE).** **R. C. Evans* and T. A. Dickinson, Department of Botany, University of Toronto, 25 Willcocks St., Toronto ON M5S 3B2 and Department of Botany, Royal Ontario Museum, 100 Queen's Park, Toronto ON M5S 2C6.**

Stamen number variation is a recurring pattern in the genus *Crataegus* L. (as well as in some other Maloideae, e.g. *Cotoneaster* and *Photinia/Heteromeles*). The significance of this variation in *Crataegus* is being studied in the different morphotypes in relation to floral development, flower size and number, and resource allocation to gender function. Floral development is being compared in a 20–stamen variety and three 10–stamen varieties of *Crataegus douglasii*, using dissections of inflorescence apices and scanning electron microscopy. Variety *suksdorfii* is, for the most part, diploid and self–incompatible, and has flowers with approximately 20 stamens per flower. Two of the 10–stamen informal varieties (*douglasii, brockwayae, rivularis*) appear to be polyploid and self–compatible. The androecium arises as five antisepalous pairs of stamens in both the 10– and 20–stamen varieties. In var. *suksdorfii* further development comprises formation of a second whorl of five antipetalous stamens, and then insertion of a stamen between the members of each pair in the first whorl. In var. *douglasii* there is conspicuous variation in the number of stamens per flower. Varieties *brockwayae* and *rivularis* had fewer flowers per inflorescence than the other two varieties.

REPRODUCTIVE BIOLOGY OF *AGALINIS NEOSCOTICA*

Heather Stewart, Department of Botany, University of Guelph, Guelph, Ontario

*Agalinis neoscotica*, (Scrophulariaceae) has small flowers (10-15 mm long) and the style fails to elongate as in related species. Field studies conducted on *A. neoscotica* in Nova Scotia during August 1992 using seven floral manipulation treatments indicate that *Agalinis neoscotica* is self-compatible. Bagged unmanipulated plants showed the highest seed set at all four study locations. Pollen is released from anthers three days prior to anthesis and SEM micrographs show pollen on the stigma prior to anthesis. However, fluorescence microscopy shows no pollen tube growth prior to or on the day of anthesis. Growth of pollen tubes is evident on the second day of anthesis when the corolla has started to wither. Isozyme analysis, in progress, could determine whether this delay in pollen germination allows for some degree of outcrossing to occur. Growth room studies confirm the relative timing of floral events and allow comparison with those in the close relative *A. paupercula*.

Plant Communication

by Scott Dunlop

Communication in plant ecosystems is the basis of many ecological interactions. Plants communicate between each other, as well as with other organisms in their environment. Many plant and tree species are able to change the chemical balance of their foliage to make it less palatable and increases the levels of phenolics within foliage. Although not yet fully understood, their also appears to be rudimentary communication between individual trees over a considerable distance. Communication within one tree and between trees is believed to be based on some type of gaseous messenger, such as ethylene. Other possible communication mediums include W-waves, but their potential requires much more research.

## BAD AND GOOD UV INFLUENCE ON *RUTA GRAVEOLENS* LEAVES

Y. Chen and A.M. Zobel, Chemistry, Trent University, Peterborough, ON K9J 7B8

Monochromatic 366 nm irradiation of *R. graveolens* potted plants caused increased concentrations of furanocoumarins in the leaves, with dramatic extrusion of these compounds to the surface. Shorter wavelength irradiation (254 nm), which is said to be harmful to the cells, was used here, and the detached leaves were investigated for a 7-day period. Furanocoumarin concentrations were evaluated. Both qualitative and quantitative differences were observed. Changes to the leaf structure and the surface of the cuticle were observed under the electron microscope.

## FURANOCOUMARINS AS PHYTOALEXINS IN CELERY AND RUE

J. Crellin and A.M. Zobel, Chemistry, Trent University, Peterborough, ON K9J 7B8

Increased concentrations of furanocoumarins due to pathogens are known in celery, but a distinction between surface deposits and those within the leaf has been made here for the first time. Up to a 400% increase in the concentrations of psoralen, bergapten, xanthotoxin and isopimpinellin was observed. In the control plant, rue leaves contained over 100 times more furanocoumarins on the surface than did celery, and the trends of accumulation of furanocoumarins as phytoalexins were different in these two plants.

## COUMARINS IN THE INTERACTION BETWEEN PLANT AND ENVIRONMENT

Stewart A. Brown and Alicja M. Zobel, Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Coumarins are increasingly recognized as important in the interaction between the plant and its environment. They act as allelochemicals, functioning, for example, in interactions with herbivores, and in communication with insects as attractants or antifeedants. One category, the psoralens, can act as phytoalexins, providing a defense against microbial attack. Psoralens are also germination regulators, inhibiting the growth of the seeds of other competing species, or acting as autoinhibitors to delay germination of the seed producing them while awaiting more favourable conditions. The location of coumarins can be of significance in some interactions, and evidence has been obtained on the role of compartmentation on the leaf surface in this respect. As well, coumarins are affected in diverse ways by environmental stress on the plant, such as that due to altitude, temperature variations, change of locale and ultraviolet radiation, and from the unnatural environment induced by air pollution. This class of "secondary" plant products is thus assuming primary importance in the present context.

THE PHYLLOTAXIS OF THE INFLORESCENCE OF *SYMPLOCARPUS FOETIDUS*

Denis Barabé, IRBV, Jardin botanique de Montréal

The inflorescence of *Symplocarpus foetidus* constitutes a good material to analyse the biological processes and physical constraints involved in the development of plants. At the adult stage, the inflorescence has and ovoid form. It contains about 90 flowers with a hexagonal or pentagonal perimeter. The floral primordia appear sequentially from the basal to the upper part of the inflorescence. Growth zones can be recognized, but it is not possible to determine the order of appearance of successive flowers. The phyllotactic system is generally 3(2,5) or 4(3,4). It corresponds to the series k(1, 2, 3, 5, ...). The younger primordia have a circular form that they lose when the floral parts begin to grow. The contact parastichies can be recognized during the first stages of development. But when the floral parts begin to grow, the phyllotactic system loses its regularity. During the development of the inflorescence, two morphogenetic periods can be distinguished. In the early stages, when the floral primordia appear, the phyllotactic system would be constrainted by the form of the inflorescence. After that, the development of floral parts produces patterns which can be explained by local processes.

THE MORPHOGENESIS OF THE PROTOCORM OF CYPRIPEDIUM ACAULE Aiton (ORCHIDACEAE).

Gilles Leroux, Denis Barabé and Joachim Vieth. Institut de recherche en biologie végétale, Jardin botanique de Montréal.

The nature of the orchid protocorm has evoked the interest of morphologists for more then a century. The problem of interpreting the nature of the protocorm can be addressed from either a structural or a functional point of view. In the seed, the undifferentiated embryo contains about one hundred cells. We can recognize an antero-posterior axis in the embryo. In the first stages, a scale will develop from the meristematic tissue located at the apical pole. At the same time, we observe the formation of the apex of the future plantlet at the base of the scale. The apex and the scale (first leaf?), even if they are located in the upper part of the protocorm, don't belong to the same phyllotactic system. The structural study of the development of the seed of C. acaule shows that the protocormial root (first root), the protocorm and the first leaf constitute a morphological system that differs from the rest of the seedling. The protocorm can be interpreted as an extension of the proembryo in the sense of Souèges. It would constitute the true embryological stage of the plant.

IDENTIFICATION OF THE SITES OF SOLUTE LEAKAGE FROM IMBIBING SEEDS AND GRAINS.

P. Beecroft & J. Lott, Dptmt of Biology, McMaster University, Hamilton, Ont.

As water is absorbed into seeds during imbibition, inorganic ions, sugars, proteins, amino acids and organic acids leak out of the seed. Leakage varies for different solutes, different species and different seed tissues. The goal of this study was to develop a method for detecting where on the seed surface imbibitional leakage occurs. Potassium loss from seeds is substantial and is beleived to be a general indicator of electrolyte release. The method developed, therefore, was specific for K. The successful procedure adopted involved imbibing seeds partially embedded in moist agar, removing the seeds and freeze-drying the agar, and then treating the agar with sodium lead cobaltous hexanitrite. We present the results of the most comprehensive study to date of sites of K leakage from soybean, pea, squash and corn seeds/grains. Neutron activation analysis (NAA) was used to determine whether or not K was leaked into the agar and energy dispersive X-ray (EDX) analysis was used to document the presence of K in the testae/pericarps of the test material before and after imbibition.

LEAD UPTAKE INTO SOYBEAN ROOT CELLS AS INFLUENCED BY pH.

R. Crang[1], M. Kuras[2] and A.M. Zobel[3], [1]Plant Biology, University of Illinois, Urbana, IL 61801, [2]Electron Microscopy, Warsaw University, 00-927 Warsaw, Poland, and [3]Chemistry, Trent University

In an ultrastructural study of lead ($PbCl_2$) uptake into germinating soybean (*Glycine max*, cv. Williams) seeds under varying pH consitions, it was found that even though the lead was more chemically mobile at low pH, the early-developing plant tissues were physiologically unable to transport and accumulate the metal intracellularly. The lead deposits were always surrounded by membranes while inside the protoplast, suggesting a defense mechanism of the cell.

IDENTIFICATION OF COMPOUNDS PRODUCED IN RESPONSE TO UV

J. Snelgrove, J. Bazdikian, R.E. March and A.M. Zobel, Chemistry, Trent University, Peterborough, ON K9J 7B8

In leaves of *R. graveolens* irradiated by 366 nm UV, different peaks were visible on HPLC chromatograms compared to those from control leaves. Quantitative and qualitative differences were visible both in the fraction removed from the surface, thus directly influenced by UV, and from the interior of the leaf. Gas chromatography-mass spectrometry allowed some of the peaks to be identified. UV may change the physiology of the cells, resulting in the production of new compounds simultaneously with quantitative changes in the concentrations of compounds in the control plants.

UPTAKE AND TRANSLOCATION OF $PbSO_4$ BY ROOT AND SHOOT PROMERISTEMS.

M. Wierzbicka[1] and A.M. Zobel[2], [1]Electron Microscopy, Warsaw University, 00-927 Warsaw, Poland, and [2]Chemistry, Trent Univer sity, Peterborough, ON K9J 7B8

Inital cells of both root and shoot apices seem to be protected from lead ions taken up from solution. On longitudi nally cut sections of the root tip and on squash preparations of the shoot apical internodes the central part of the apex did not contain lead ions. Observations in the EM revealed that in onion root after treatment with different lead salts the changes were in the chromosomes. Lead ions were sequestered from the cytoplasm by isolation in ER membranes and in vacuoles, as well as in the cell wall. In the shoot apex of *Pinus nigra* the changes led to increased concentrations of phenolic ompounds in the vacuoles which were similar to those induced by $H_2SO_4$ spray, suggesting that the changes were rather due to $SO_4^=$.

EPICATECHECHINS FROM *SAMBUCUS RACEMOSA* INHIBIT MITOSIS IN THE PROMERISTEM.

M. Gadzala and A.M. Zobel, Dept. of Plant Anatomy and Cytology, Warsaw University, 00-927 Warsaw, Poland.

Epicatechins extracted from *S. racemosa* leaves and pure compounds isolated inhibited mitosis in the promeristem of *Allium cepa* root tips. Changes in structure observed in the electron microscope indicated damage to endomembranes, vacuolization, and alteration of mitochondrial cristae, suggesting an effect of these compounds on respiration. Biochemical investigation on isolated mitochondria showed changes in the uptake of oxygen parallelling the inhibition of mitosis. The small number of aberrations indicated that the target of these compounds is not chromatin but rather physiological processes in the cytoplasm.

INFLUENCE OF COUMARIN AND XANTHOTOXIN ON OXYGEN CONSUMPTION.

S. Barrett, A. Ruchirawat and A.M. Zobel, Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Plant cells which contain furanocoumarins (rue) and those without coumarins (brussels sprouts) were treated for 5 min, 1 h and 24 h either with coumarin or xanthotoxin, both compounds known as antimitotics. Concentrations above 20 ppm were found to lower the uptake of oxygen, but below 10 ppm they were unexpectedly found to have a stimulatory effect. The reaction of xanthotoxin depended on ultraviolet radiation. Experiments with a fraction of broken mitochondria prepared from cow heart muscle confirmed a link between respiration and the action of coumarin inside the cells.

EFFECT OF COUMARIN AND ITS DERIVATIVES ON MITOSIS AND ULTRA STRUCTURE OF MERISTEMATIC CELLS OF *ALLIUM CEPA*.

M. Podbielkowska[1], M. Piwocka[1], E. Waszkowska[1], M. Waleza[1] and A.M. Zobel[2], [1]Plant Anatomy and Cytology, Warsaw University, 00- 927 Warsaw, Poland and [2]Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Chromosomal aberrations observed after psoralens and 7- hydroxycoumarin were due to microtubule disorder and strong condensation of chromatin. 7-Hydroxycoumarin caused the most profound changes in ultrastructure, which suggests aberrations in the energy metabolism of the cells. Polymorphic mitochondria showed a dense matrix and were swollen. Long cisternae of mostly rough ER built up parallel arrangements, longitudinal or spherical. The rest of the compounds influenced the structure of the mitochondria and increased vacuolization of meristematic cells.

LOCALIZATION OF PKc AND PKp IN GERMINATING EMBRYOS OF *BRASSICA*

[1]L. Lazaruk, [2]W. Plaxton and [1]A.M. Zobel, Chemistry, Trent University, Peterborough, ON K9J 7B8, and Biology, Queen's University, Kingston, ON N7L 3N6

Germinating seeds of *Brassica napus* L. were fixed after 24 h of imbibition, the time necessary to restore biosynthetic activity in the embryo. The monospecific polyclonal antibodies of cytoplasmic phosphokinase (PKc) and plastid phosphokinase (PKp) were prepared by a method previously described by Plaxton. PKc was mostly located in the cytoplasm, whereas PKp was 60-70% in the plastids and the rest in the cytoplasm, at this stage of embryo differentiation.

EFFECT OF COUMARINS ON ROOT ELONGATION AND ULTRASTRUCTURE.

E. Kupidlowska[1], M. Kowalec[1], G. Sulkowski[1] and A.M. Zobel[2], [1]Plant Anatomy and Cytology, Warsaw University, 00-927 Warsaw, Poland and [2]Dept. of Chemistry, Trent University, Peterborough, ON K9J 7B8

Growth of roots of cucumber, pea and corn seedlings was totally inhibited by coumarin and xanthotoxin, and retarded by 7-hydroxycoumarin. The most resistant to coumarins was pea, and the most susceptible was cucumber. These compounds altered the structure of endomembranes of meristematic cells. Fragmentation of the ER was observed. Dictiosomes decreased in number and were inactive. The morphology of those mitochondria with a dense matrix points to an energy deficit in meristematic cells.

# PLANT DEVELOPMENT WORKSHOP

## MARCH 20, 1993

## TRENT UNIVERSITY

## PETERBOROUGH, CANADA